

Solar Power: A History

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Solar energy is not only our future, it is also our past and present

Our world is changing and growing every day. Along with all of these changes come increased demands on our resources to provide such fundamentals as food and energy. Right now, we heavily rely on **fossil** fuels such as oil, natural gas and coal to provide us with energy to our homes and our various modes of transportation. However, fossil fuels don't last forever. We need to increase our use of renewable resources such as Solar Energy to help us meet our future energy demands. In order to do that, we must first look at the past: the progression of solar energy, the present: how we use solar energy today, and finally the future: what will be doing years down the road to harness more energy from the sun.

Most people today are familiar with solar panels, perhaps you even know someone who has solar panels on their home or where they work, perhaps on their car as well. You may be surprised to learn that you yourself may have them in your home right now! Try to find a calculator that does not require batteries. However, harnessing solar energy has been around for a very long time. How long do you think we have been harnessing energy from the sun?

Do you have an answer yet? Is it 50 years? 100 years? 1000 years. Other than the sun just warming us naturally, how long have we been focusing or managing its energy on purpose? The answer may be surprising. People have been harnessing energy from the sun as far back as the 7th century BC. That is more than 2700 years! So what did they do?

Ancient civilizations used sunlight with mirrors

In the 7th century BC, people would use a magnifying glass to focus rays of light from the sun. People focused the rays of light for a variety of reasons. The light rays were focused for warmth, cooking or to light some fuel source. It wasn't that long before people realized they could focus these light rays for other uses. Some speculated that they too burned ants.

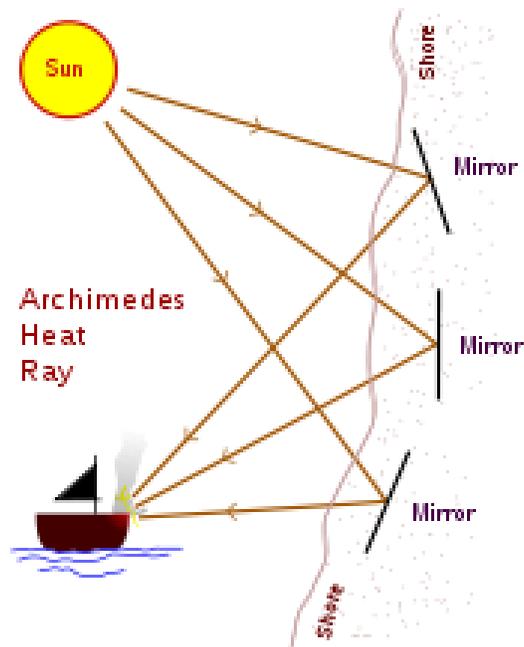
Mirrors came into play a short time later. Mirrors were also used to focus sunlight for various religious purposes with the Greeks and Romans starting around the 3rd century BC. In fact, some speculate that this is how the Olympic torch was lit (**Figure a**). This idea is strongly rooted in Greek Mythology. This flame commemorates Prometheus, one of the Titans, stealing fire from Zeus so that he could give it to all humans. The sacred flame was lit from the sun's rays that originated at Olympia. Thus, the flames remained lit throughout the entire Olympic ceremonies.



Caption (a): A reenactment of Ancient Greeks showing the lighting of a torch with a parabolic mirror.

Source: <https://www.tribuneindia.com/2004/20040325/spr1.jpg>

It wasn't long after this that people figured out how to turn solar power into a weapon. Legend has it that as early as 212 B.C., Archimedes used the reflective properties of bronze shields to focus the sunlight and then set fire to the Romans' wooden ships. It is known that Syracuse was invaded at this time and when Archimedes himself lost his life. However, there is no evidence that these "death rays" were used to ward off the attacking ships (**Figure b**). But could they? The debate continues on and has yet to offer a definitive answer. In 1973, the Greek navy recreated this experiment and they were able to burn a wooden ship about 50 m (160 ft) away from them. MIT students did this in 2006 as well and recently Mythbusters showed that they needed perfect conditions in order to get even cinders on the wooden shape. So did Archimedes actually create and use this mirror system? Nobody knows for sure! We do know that modern parabolic mirrors can focus the sun's rays and raise the temperature to an incredible 400 F (**Figure c**)!



Caption (b): A possible array of mirrors used to set fire to enemy ships with Archimedes' weapon.
Source: <https://en.wikipedia.org/wiki/Archimedes>



Caption (c): Examples of parabolic mirrors used for cooking.
Source: <https://science.howstuffworks.com/environmental/green-science/solar-cooking.htm>

FYI: "What was Archimedes' death ray?"
This page provides additional insight into Archimedes' famed death ray.
<http://history.howstuffworks.com/ancient-greece/archimedes-death-ray2.htm>

Many civilizations used solar power in their homes

Shortly into the start of the 1st century through the 4th century AD, solar power was used in homes. Nothing like how we use solar power today, but rather people would build their homes and other structures like Roman bath houses to maximize the sun's energy. For example, Roman bath houses had large windows with southern exposure to allow a great deal of sunlight into the bath houses. Sunrooms in houses and buildings became so common that laws were put into place in the 6th century AD to ensure every building has access to the sun. This is what the Justinian code (legal code of Ancient Rome) called "Sun Rights."

It wasn't just the Romans who recognized the importance of building homes to maximize the sun's energy. In the 13th century, the Anasazi (ancestors of the Pueblo people) built their cliff dwellings facing the south (**Figure**). They did this again to maximize the amount of energy from the sun. So this beckons the question, why is a southern exposure so desirable?

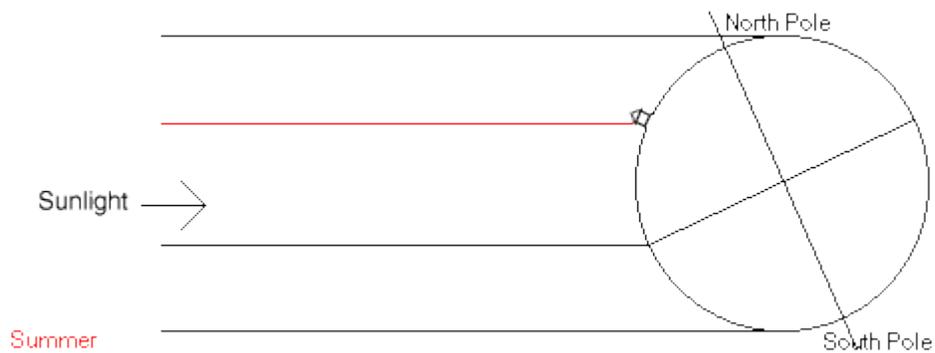


Caption: A typical cliff dwelling of the Anasazi people.

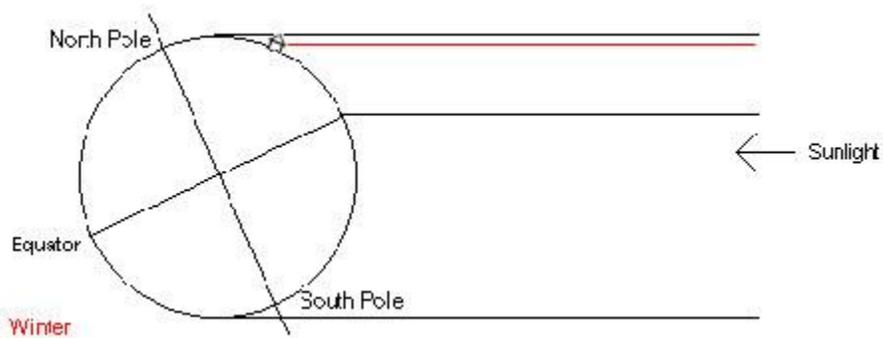
Source: <https://www.nationalgeographic.org/media/cliff-palace/>

Why do we care about southern exposure?

Ask any realtor and they will tell you the importance of southern exposures. However, this is only true in the northern hemisphere (**Figure a**). If you were a realtor in South America, Northern exposure is more important. Here in the U.S. the sunlight comes from the south. This is for two reasons, one the Earth is roughly spherical and two, the Earth is tilted on the axis by about 23° (this is also gets into why we have seasons). Look at the following illustration:



The arrangement of the house and sun in the summer

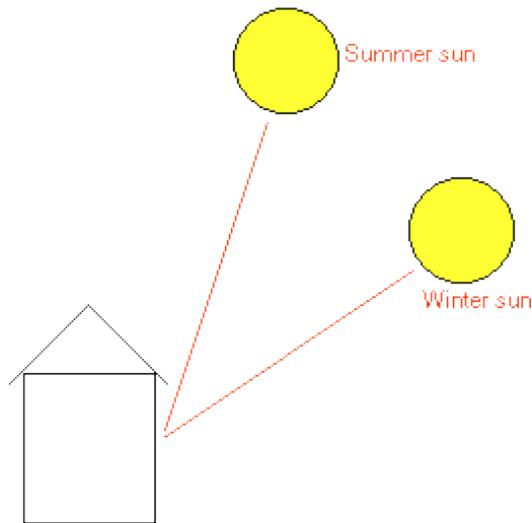


The arrangement of the house and sun in the winter

Caption (a): Arrangements of the house and sun in different seasons.

Source: <http://static.howstuffworks.com/gif/earth-house-win.jpg>

In the summer, you can see a house sitting on the Earth in the picture above. The sunlight comes in on the left side, but from the perspective of the house, it is directed to the South. Even in the winter, when the Earth is on the opposite side of the sun, the sunlight still appears to come in from the South (from your perspective inside the house). Now this brings in another architectural design: that is the placement of eaves in your house. Eaves are those small overhangs on the side of your house. If you have a deep eave, that will allow the winter sunlight to come in, but during the summer time, the sunlight will be blocked which will prevent the house from getting warmer. This has to do with the position you see the sun in the sky. If you look at the figure **(Figure b)**, the summer sun is much higher in the sky than the winter sun. Thus, the eaves will help to let all of the warmth from the winter sun in but not let in too much warmth in during the summer.



Caption (b): Position of the sun during different seasons.

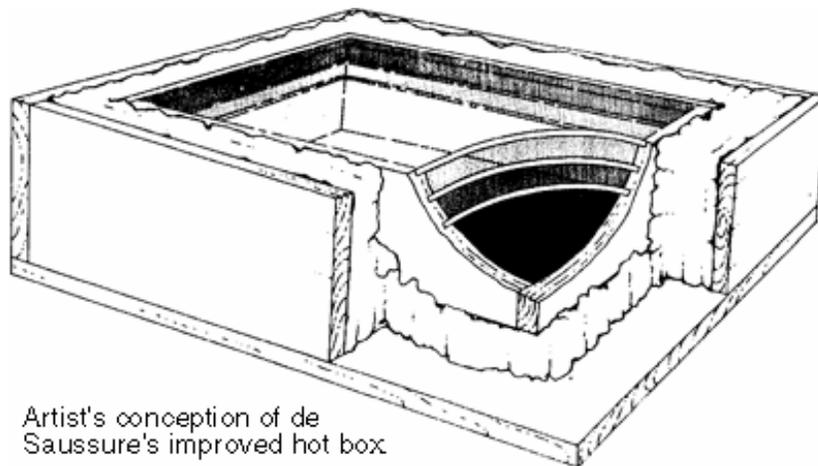
Source: <http://static.howstuffworks.com/gif/earth-house3.gif>

Cooking without wood, gas or electricity – just the Sun

Surprisingly, it took a little bit of time before people started to use solar energy beyond their home. One of the next big steps in the use of solar energy is for cooking food. A big part of the reason that solar energy was used for cooking was due to another material that was becoming widely used in the 18th century: glass. If you ever sat in a sunroom or a car on a hot day with the windows up or you notice that you get pretty warm pretty quickly. People in the late 1700s noticed this as well. Nobody did any scientific work with this idea until a gentleman by the name of Horace de Saussure came along. Though his colleagues were more interested in burning things with mirrors, he was interested in understanding how well glass could trap thermal energy.

*De Saussure first built a miniature greenhouse five walls thick (**Figure a**). He constructed it from five square boxes of glass, decreasing in size from 12 in. on a side by 6 in. high to 4 in. on a side by 2 in. high. The bases of the boxes were cut out so the five boxes could be stacked one inside the other atop a black wooden table. After exposing the apparatus to the sun for several hours, and rotating the model so that solar rays always struck the glass covers of the boxes perpendicularly, de Saussure measured the temperature inside. The outermost box was the coolest, and the temperature increased in each succeeding smaller box. The bottom of the innermost box registered the highest temperature—189.5° F. "Fruits. . . exposed to this heat were cooked and became juicy," he wrote.¹*

¹This paragraph was taken from <http://solarcooking.org/saussure.htm>.

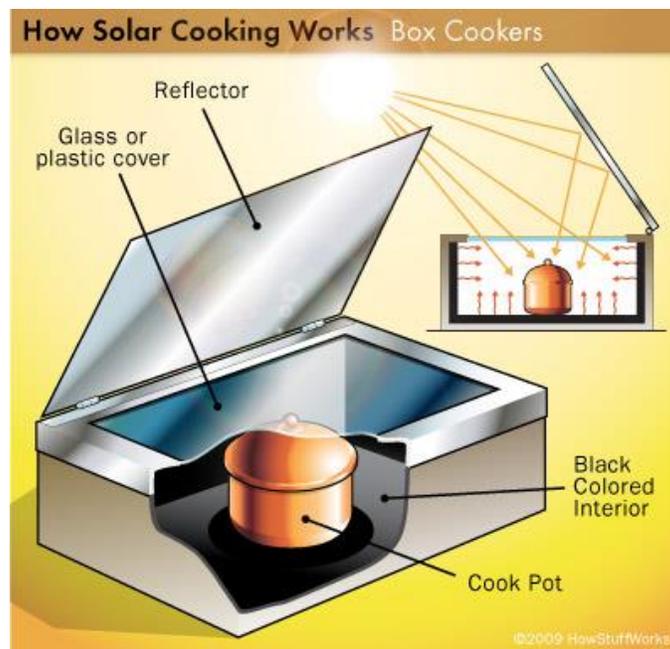


Artist's conception of de Saussure's improved hot box

Caption (a): Artist's rendition of de Saussure's hot box.

Source: <http://solarcooking.org/saussure.htm>

So how do solar cookers work? **(Figure b)** We first need to understand one thing about sunlight: sunlight is a form of electromagnetic radiation. Sunlight itself isn't "hot." It's the effect that the radiation has on objects that makes us feel warm from sunlight. When the light hits your skin, the electro-magnetic radiation causes the molecules in your skin to speed up. As the molecules speed up, the amount of energy they possess also increases, and your skin feels warmer because you have more thermal energy. Solar cookers work the same way. With the solar cooker, the glass top allows the radiation to penetrate through the glass. The sunlight hits the surface on the inside and causes the energy to increase which in turn makes objects warmer. Though the glass lets the sunlight in, it does not let the thermal radiation out, so energy keeps being added to the cooker, but does not easily leave it. As a result, the temperature gets very high inside the solar cooker. To increase the amount of energy going to the food being cooked, the inside of the cooker will be covered with mirrors or some other type of reflective surface. Temperatures can get upwards of 300 degrees Fahrenheit, or roughly 150 degrees Celsius. At this temperature you can safely cook many types of foods. You can go try cooking your own meal with your solar cooker. You can go searching on the Internet and buy a solar cooker to use in your own home or you can make your own.



Caption (b): How a solar box cooker works.

Source: <https://science.howstuffworks.com/environmental/green-science/solar-cooking1.htm>